

MODIS

Science Data Processing Software

Beta Release Requirements Specification



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Science Data Processing Software
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Prepared By:

Jenny Glenn, General Sciences Corporation/SAIC
SDST Systems Analyst

Date

Reviewed By:

Barbara Putney, GSFC/Code 920
MODIS Systems Engineer

Date

Jim Firestone, General Sciences Corporation/SAIC
SDST STIG Lead

Date

Laurie Schneider, General Sciences Corporation/SAIC
SDST R&QA Manager

Date

Dr. Al Fleig, University of Maryland

Date

Tom Piper, General Sciences Corporation/SAIC
MODIS Task Leader

Date

Approved By:

Edward Masuoka, GSFC/Code 920
MODIS SDST Manager

Date

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MODIS

Science Data Processing Software

Beta Release Requirements Specification

1. INTRODUCTION

1.1 Purpose

This document is the requirements specification for the Beta Release of the Moderate Resolution Imaging Spectroradiometer (MODIS) Science Data Processing Software (SDP S/W) system. The Beta Release shall be developed in the MODIS Team Leader Computing Facility (TLCF) at Goddard Space Flight Center (GSFC) and migrated to the GSFC Distributed Active Archive Center (DAAC) between April 1, 1995 and January 31, 1996. The requirements stated specify the capabilities and functions that shall be implemented to support all data input, processing, and output for the Beta Release.

1.2 Scope

The major software elements provided by the Science Data Support Team (SDST) and the MODIS Characterization Support Team (MCST) include: Level 1A (L1A) and Level 1B (L1B) Processing Software, Geolocation Processing Software, Product Generation Executable (PGE) scripts, and MODIS Application Program Interface (M-API) utilities. The major software elements contributed by the Science Team Members (STM) are the Higher Level Science Algorithms; i.e., Level 2 (L2), Level 3 (L3), and Level 4 (L4) Processing Software as described in the MODIS Software Management Plan.

This plan has been written using NASA-STD-2100-91 and supplemented by applicable Department of Defense (DoD) standards.

1.3 Beta Release Goals

The overall goals for the Beta Release include:

- Provide a verification that the Science Data Production (SDP) Toolkit meets MODIS's requirements and functions properly in the MODIS processing context.
- Provide an understanding of the interfaces between MODIS algorithms.
- Provide an identification of risk areas within algorithms and supporting MODIS processing software.
- We will have working code from each Science Team Algorithm Developer that addresses every at launch product for that developer.
- We will have all required inputs identified for each algorithm.
- We will have defined the format and content of the output datasets for all algorithms.
- We will have integrated algorithms into threads of execution.
- We will have structured the code such that input/output is isolated from the control and core algorithm functionality.

- We will have developed simulated data sets that can be used in the initial testing of the Beta algorithms. These datasets will not be based on a full end-to-end sensor model. They will be simplified, non-physical, simulated datasets that are usable by multiple algorithms (threads).
- We will be executing algorithms under a higher level processing shell in the TLCF and SDP.
- The software processes integrated into the Beta Release will not be required to ingest or output data conforming to the MODIS bands or data in Hierarchical Data Format (HDF) format.

1.4 Content and Structure

This document has been organized into the following sections:

- Section 1 provides the background and introduction to this document
- Section 2 details the system-level requirements for the Beta Release
- Section 3 spells out process-specific requirements
- Section 4 identifies product-specific requirements
- Section 5 details requirements associated with the PGEs
- Section 6 details requirements associated with the operations environment
- Section 7 identifies the acronyms and abbreviations used in this document

1.5 Relevant Documents

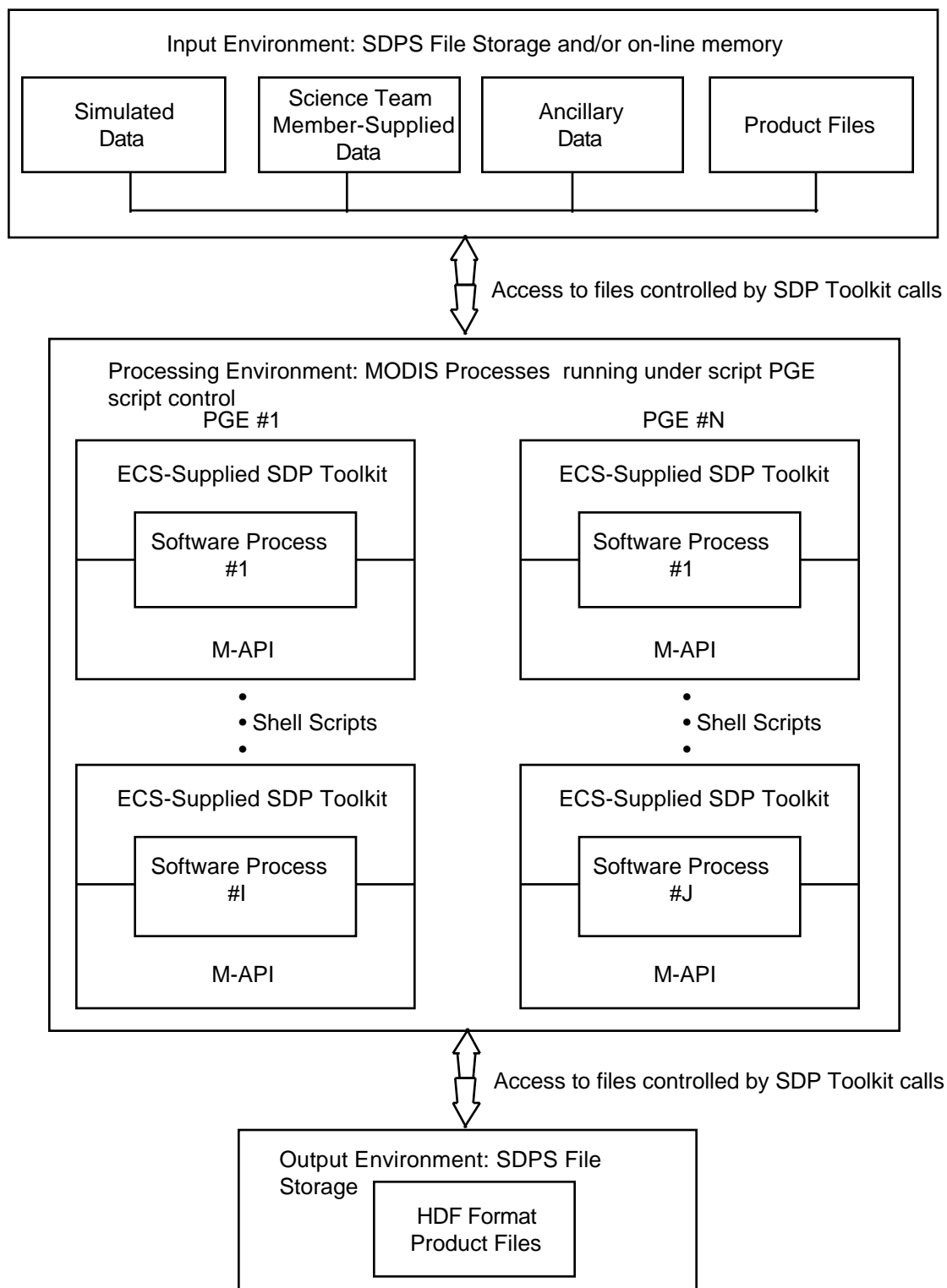
The following documents serve to provide information relevant to the MODIS Beta Release Requirements Specification document:

- MODIS Software Management Plan; SDST; SDST-002.
- Science Software and Data Management Requirements-Preliminary Draft Version, ESDIS Project, July, 1993.
- MODIS Operations Concept Document-Version 1, SDST, August, 1993.
- Team Leader Working Agreement for MODIS Between EOS AM & PM Projects GSFC and the MODIS Science Team Leader, April 21, 1994, GSFC 421-12-14-02.
- MODIS Software Development Standards (SDS) and Guidelines, Version 1, February 15, 1995.
- Science User's Guide and Operations Procedure Handbook for the ECS Project, Part 4: Software Developer's Guide to Preparation, Delivery, Integration, and Test with the ECS; 205-CD-002-001, January, 1995.
- Data Production Software (DPS) and Science Computing Facility (SCF) Standards and Guidelines; January, 1994.
- Science Software Integration and Test Procedures for the MODIS Instrument at the GSFC DAAC; SDST; SDST-017.

2. BETA RELEASE SYSTEM-LEVEL REQUIREMENTS

The executable environment of the SDP S/W is shown in Figure 2-1, MODIS Beta Release SDP S/W Context Diagram.

- 2-1 When delivered to the GSFC DAAC, the integrated software system shall be identified as the MODIS SDP S/W Beta Release 1.0.
- 2-2 The Beta Release 1.0 shall integrate all software processes available to the SDST software integration team into a prototype SDP S/W system that executes in the MODIS TLCF and the GSFC DAAC environments.
- 2-3 A software process shall be available for integration into the MODIS SDP S/W Beta Release 1.0 after it has been accepted into the SDST Configuration Management Officer's baselined library directory.
- 2-4 A software process shall be placed in the SDST Configuration Management Officer's (CMO) baselined library after it has passed the Code Acceptance Process detailed in the MODIS Software Management Plan.
- 2-5 Configuration Management (CM) of the released software in the TLCF, and during the infusion process in the DAAC, shall be the responsibility of the MODIS SDST. The CM of the released software after it has been accepted for production use is the responsibility of the GSFC DAAC.
- 2-6 The Beta Release 1.0 shall operate on a Silicon Graphics platform under the IRIX 6.0 or higher operating system running in 32-bit mode.
- 2-7 The Beta Release 1.0 of the SDP S/W and all subsequent incremental releases, if any, shall use SDP Toolkit Version 5.
- 2-8 All mandatory SDP Toolkit functions, which include generic file Input/Output (I/O), the Process Control File (PCF), and the Status Message Facility (SMF) shall be incorporated as required into all software elements in the Beta Release 1.0 and all subsequent incremental releases, if any.
- 2-9 The PGEs shall be supplied by the SDST as part of the Beta Release 1.0.
- 2-10 The M-API libraries used by the software processes shall be supplied to the MODIS TLCF and the GSFC DAAC by SDST as part of the Beta Release 1.0.
- 2-11 All software incorporated into the Beta Release 1.0 and subsequent incremental releases shall be implemented in Earth Science Data and Information System (ESDIS)-approved languages or be covered by a ESDIS-approved waiver.
- 2-12 A Level 2 Grid (L2G) utility shall be available for use with the Beta Release.
- 2-13 The L2G utility shall group portions of orbits of MODIS L2 data in swath format into processing files based on geographic location. These processing files are defined as the cells of a 10° x 10° modified International Satellite Cloud Climatology Project (ISCCP) grid.

**Figure 2-1 MODIS Beta Release SDP S/W Context Diagram**

3. BETA RELEASE SOFTWARE PROCESS REQUIREMENTS

- 3-1 A software process shall be defined as any element of executable software listed in Table 3-1. The processes listed in Table 3-1 reflect the software that is scheduled for inclusion in the MODIS SDP S/W Beta Release 1.0.
- 3-2 The data interfaces of each software process shall be defined by the most recent release of the relevant product specification.
- 3-3 A software process which ingests the output of another MODIS process shall ingest the format defined by the most recent release of the relevant product specification.

3.1 L1A and Geolocation Beta Release Process Definition

The Beta Release of the MODIS L1A/Geolocation software will meet the requirements specified in the MODIS L1A Software Baseline Requirements as maintained by the SDST CMO with the following exceptions:

- 3.1-1 The Beta Release Geolocation Software will be tested and delivered with a Digital Elevation Model (DEM) file covering the continental United States.

3.2 Beta Release Thread Definition

- 3.2-1 A thread is a logical concept used to define the data product dependencies between processes.
- 3.2-2 Thread 1 is defined as MOD_PR01, MOD_PR03, MOD_PR02.
- 3.2-3 Thread 2 is defined as MOD_PR35, MOD_PR07, MOD_PR09/13/14, MOD_PR10, MOD_PR11.
- 3.2-4 Thread 3 is defined as MOD_PR04.
- 3.2-5 Thread 4 is defined as MOD_PR05.
- 3.2-6 Thread 5 is defined as MOD_PR06TP.
- 3.2-7 Thread 6 is defined as MOD_PR06OD.
- 3.2-8 Thread 7 is defined as MOD_PR06IR.
- 3.2-9 Thread 8 is defined as MOD_PR29.
- 3.2-10 Thread 9 is deleted.
- 3.2-11 Thread 10 is defined as MOD_PR18, MOD_PR27.
- 3.2-12 Thread 11 is defined as MOD_PR09.
- 3.2-13 Thread 12 is defined as MOD_PR15, MOD_PR16, MOD_PR17.
- 3.2-14 Thread 13 is defined as MOD_PR33, MOD_PR34, MOD_PR42.
- 3.2-15 Thread 14 is defined as MOD_PR12.

3.3 Beta Release Processing Sets

- 3.3-1 A processing set is a list of processes ordered in a sequence that represents a portion of the anticipated Version 2 system.
- 3.3-2 Processing Set One shall consist of MOD_PR01, MOD_PR03, MOD_PR02, MOD_PR07, and MOD_PR35.
- 3.3-3 Processing Set Two shall consist of MOD_PR05, MOD_PR04, MOD_PR06, MOD_PR09/13, MOD_PR10, and MOD_PR11.
- 3.3-4 Processing Set Three shall consist of MOD_PR18 and MOD_PR27.
- 3.3-5 Processing Set Four shall consist of MOD_PR29.
- 3.3-6 Processing Set Five shall consist of the Level 2G, MOD_PR33, MOD_PR34, and MOD_PR40.
- 3.3-7 Processing Set Six shall consist of the MOD_PR09 16 day Level 3 process and MOD_PR12.
- 3.3-8 Processing Set Seven shall consist of MOD_PR15, MOD_PR16, and MOD_PR17.

Table 3-1 MODIS Software Process Definition

Process ID	Process Name	Output Prod ID	Proc Level	Principal Investigator
MOD_PR01	Level 1A Raw Counts	MOD01	1A	SDST
MOD_PR02	Level 1B Calibrated Radiances	MOD02	1B	MCST
MOD_PR03	Level 1A Geolocation	MOD03	1A	SDST
MOD_PR04L	Level 2 Aerosol - Land	MOD04L	2	Kaufman
MOD_PR04S	Level 2 Aerosol - Sea	MOD04S	2	Kaufman
MOD_PR05	Level 2 Near Infrared Precipitable Water	MOD05	2	Kaufman
MOD_PR06OD	L2 Cloud Optical Depth	MOD06OD	2	King
MOD_PR06CT	L2 Cloud Top Properties	MOD06CT	2	Menzel
MOD_PR06IR	L2 IR Cloud Phases	MOD06IR	2	Menzel
MOD_PR07	Joint L2 Process to Generate Products 07, 08, 30, 38	MOD07, 08, 30, 38	2	Menzel
MOD_PR09B	BRDF/ALBEDO	MOD09	3	Strahler
MOD_PR09GA	Tiling Geolocation Angular Data - 2G	MOD09_ANG_1KMG	2G	Justice
MOD_PR09PRPG	L2G Pointer Map	MOD_09P_1KMG MOD_09P_500MG MOD_09P_250MG	2G	Justice
MOD_PR09G/13G	Tiling Surface Reflectance/ Vegetation Indices - 2G	MOD09/13_500MG MOD09/13_250MG	2G	Justice
MOD_PR09/13/14	Surface Reflectance/Thermal Anomalies/Vegetation Indices	MOD09/13/14	2	Justice
MOD_PR10	Snow Cover	MOD10	2	Salomonson
MOD_PR10G	Tiling Snow Cover -2G	MOD10G	2G	Salomonson
MOD_PR11	Level 2 Land Surface Temperatures and Emissivities	MOD11	2	Wan
MOD_PR11A	Level 3 Land Surface Temperatures and Emissivities	MOD11A	3	Wan
MOD_PR11G	Tiling Level 2 Land Surface Temperatures and Emissivities	MOD11G	2G	Wan
MOD_PR12	Land Cover Type	MOD12	3	Strahler
MOD_PR14G	Tiling Thermal Anomalies	MOD_14G	2G	Justice
MOD_PR15	Leaf Area Index/Fractional Photosynthetically Active Radiation	MOD15	4	Running
MOD_PR16	Evapotranspiration	MOD16	3	Running
MOD_PR17	Net Primary Productivity	MOD17	4	Running
MOD_PR18	Ocean color algorithms, Level 2, at Launch	MOD18, 19, 21, 25, 26, 37, 39	2/3	Evans
MOD_PR27	Ocean Primary Productivity	MOD27	3	Esaias
MOD_PR29	Sea Ice Max Extent	MOD29	2	Salomonson
MOD_PR29G	Tiling Sea Ice - 2G	MOD29_G	2G	Salomonson
MOD_PR33	Gridded Snow Cover	MOD33	3	Salomonson
MOD_PR34	Gridded Vegetation Indices	MOD34	3	Huete
MOD_PR35	Cloud Mask	MOD35	2	Menzel
MOD_PR40	L3 Thermal Anomalies	MOD40	3	Justice
MOD_PR42	L3 Sea/Ice	MOD42	3	Salomonson

4. SCIENCE DATA PROCESSING SOFTWARE PRODUCT REQUIREMENTS

- 4-1 The definition of the level of a given product shall adhere to Table 4-1, MODIS Data Level Definitions.
- 4-2 The baselined copy of each product Interface Control Document (ICD) and HDF Product File Definition, if available, shall be stored on modis-xl.gsfc.nasa.gov under STIG/documents. The files are also available on the anonymous ftp site ([ltpftp](ftp://modis-xl.gsfc.nasa.gov)) under /pub/projects/modis/hdf.
- 4-3 The detailed specification of a given product's file structure and scientific data content may be defined by the ICD and HDF Product File Definition corresponding to that product at the discretion of the Science Team Member.
- 4-4 All products shall be stored in HDF file structures as specified in the appropriate ICD and HDF Product File Specification, if the ICDs and HDF Product File Specifications exists.
- 4-5 No HDF product file may exceed two gigabytes in size for the Beta Release as the current HDF software in the TLCF and GSFC DAAC cannot accommodate files larger than this.
- 4-6 All bit data within a product (Quality Assurance [QA] information, masks, flags, etc.) shall be designed to fall within byte boundaries. An example of this would be a three bit data field. The data should be stored as one data field per byte or two data fields per byte (not eight data fields per three bytes).

Table 4-1 MODIS Data Level Definitions

Data Level	Data Definition
Level 0	Instrument data at original resolution, time ordered restored, with duplicate packets removed.
L1A	Level 0 data which are reformatted with calibration data and other ancillary data included. Geolocation information for each 1 km spatial element of the reformatted swath data will be stored as a separate product.
L1B	L1A data to which the radiometric calibration algorithms have been applied to produce radiances or irradiances.
L2	Geophysical parameter data retrieved from the L1B data by application of geophysical parameter algorithms.
L3	Earth-gridded geophysical parameter data, which have been averaged, gridded, or otherwise rectified or composited in time and space.
L4	Analyses of the lower levels of instrument data, generally involving detailed model calculations.

5. PRODUCT GENERATION EXECUTIVE REQUIREMENTS

- 5-1 A PGE shall be defined as the smallest scheduled unit of science software. A PGE may consist of a single binary executable or one or more executables wrapped by a shell script.
- 5-2 A PGE script shall execute on a Silicon Graphics workstation running IRIX 5.3 or IRIX 6 to run one or more MODIS executables.
- 5-3 The Beta Release 1.0 PGE scripts shall be invoked via the system operator.
- 5-4 When a PGE script receives an interrupt to terminate processing, it shall exit.
- 5-5 When a PGE script encounters an empty file, it shall exit.
- 5-6 When a PGE script receives an error return code from a process it launched, it shall exit.
- 5-7 A PGE script shall return control of the system to the system operator upon script completion.

6. BETA RELEASE OPERATIONS REQUIREMENTS

- 6-1 The operations activities associated with the delivery of the Beta Release to the GSFC DAAC shall be defined in Science Software Integration and Test Procedures for the MODIS Instrument at the GSFC DAAC document.

6.1 Product Generation Executive Exception Handling

- 6.1-1 The Beta Release of the SDP S/W shall provide a set of return codes that the PGE shall use to notify the Science Data Processing Segment (SDPS) of the success or failure of the execution of the PGE.
- 6.1-2 The PGE shall include the option of running in a 'debug' mode, where the debug mode provides additional execution and/or error messaging information to facilitate troubleshooting.

6.2 ECS Algorithm Integration and Test Requirements

The MODIS team was notified of the following requirements via e-mail from Tom Atwater of Hughes.

- 6.2-1 The HDF files delivered to the DAAC shall include tolerances as intervals around the SCF data values. The tolerances shall be used to ensure that output generated at the SCF and at the DAAC correspond to the same result.
- 6.2-2 Tolerance information shall be included in a file with the same file name as the HDF data file and the file extension of '.tol'. For example, if the data file name is 'data.hdf', the tolerance file name will be 'data.hdf.tol'.
- 6.2-3 Any metadata associated with data files shall be written out to an HDF file. This shall apply whether the data file is in HDF format or a binary file.
- 6.2-4 A text description identifying data type, size in bytes, and physical tolerance (for test output files) shall accompany each binary file. The test description shall have the same file name as the binary file and the file extension '.bif'.
- 6.2-5 Binary files written in a FORTRAN unformatted sequential mode supply a file-read or file-write (as appropriate) routine within the text file description. Binary files written in a FORTRAN unformatted direct access mode shall supply a file specification in the text file description.
- 6.2-6 A type reference file shall accompany the delivery if binary (unformatted) files included in the delivery. A type reference file shall be generated using software supplied by the ESDIS organization.

7. ACRONYMS AND ABBREVIATIONS

CM	Configuration Management
CMO	Configuration Management Officer's
DAAC	Distributed Active Archive Center
DEM	Digital Elevation Model
DoD	Department of Defense
DPS	Data Products Software
ECS	ESOPs Core System
EOS	Earth Observing System
ESDIS	Earth Science Data and Information System
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
HDF	Hierarchical Data Format
ISCCP	International Satellite Cloud Climatology Project
L1A	Level 1A
L1B	Level 1B
L2	Level 2
L2G	Level 2 Grid
L3	Level 3
L4	Level 4
M-API	MODIS Application Program Interface
MCST	MODIS Characterization Support Team
MODIS	Moderate Resolution Imaging Spectroradiometer
PCF	Process Control File
PGE	Product Generation Executive
SCF	Science Computing Facility
SDP	Science Data Production
SDPS	Science Data Processing Segment
SDP S/W	Science Data Production Software
SDS	Science Development Standard
SDST	Science Data Support Team
SMF	Status Message Facility
STM	Science Team Member
TLCF	Team Leader Computing Facility
V1	Version 1
V2	Version 2